



## 4.5 Fish and Wildlife Surveillance

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Contaminants in fish and wildlife that inhabit the Columbia River and Hanford Site are monitored for several reasons. Wildlife have access to areas of the site containing radioactive or chemical contamination, and fish can be exposed to contamination entering the river along the shoreline. Fish and some wildlife species exposed to Hanford contaminants might be harvested for food and may potentially contribute to offsite public exposure. In addition, detection of contaminants in wildlife may indicate that wildlife are entering contaminated areas (e.g., burrowing in waste burial grounds) or that materials are moving out of contaminated areas (e.g., through blowing dust or food-chain transport). Consequently, fish and wildlife samples are collected at selected locations annually (Figure 4.5.1). More detailed rationale for the selection of specific species sampled in 1999 can be found in DOE/RL-91-50, Rev. 2.

Routine background sampling is conducted approximately every 5 years at locations believed to be unaffected by Hanford releases. Additional background data also may be collected during special studies.

As a result of changing operations on the Hanford Site, the frequency of fish and wildlife sampling was modified significantly in 1995. Species that had been collected annually were placed on a rotating schedule so that surveillance of all key species would be accomplished over a 3-year period. Factors supporting these changes included the elimination of many onsite radiological sources and a decrease in environmental concentrations of radionuclides of interest. Additionally, several radionuclides that were monitored in the past had not been detected in recent wildlife samples because they were no longer present in the environment in sufficient amounts to

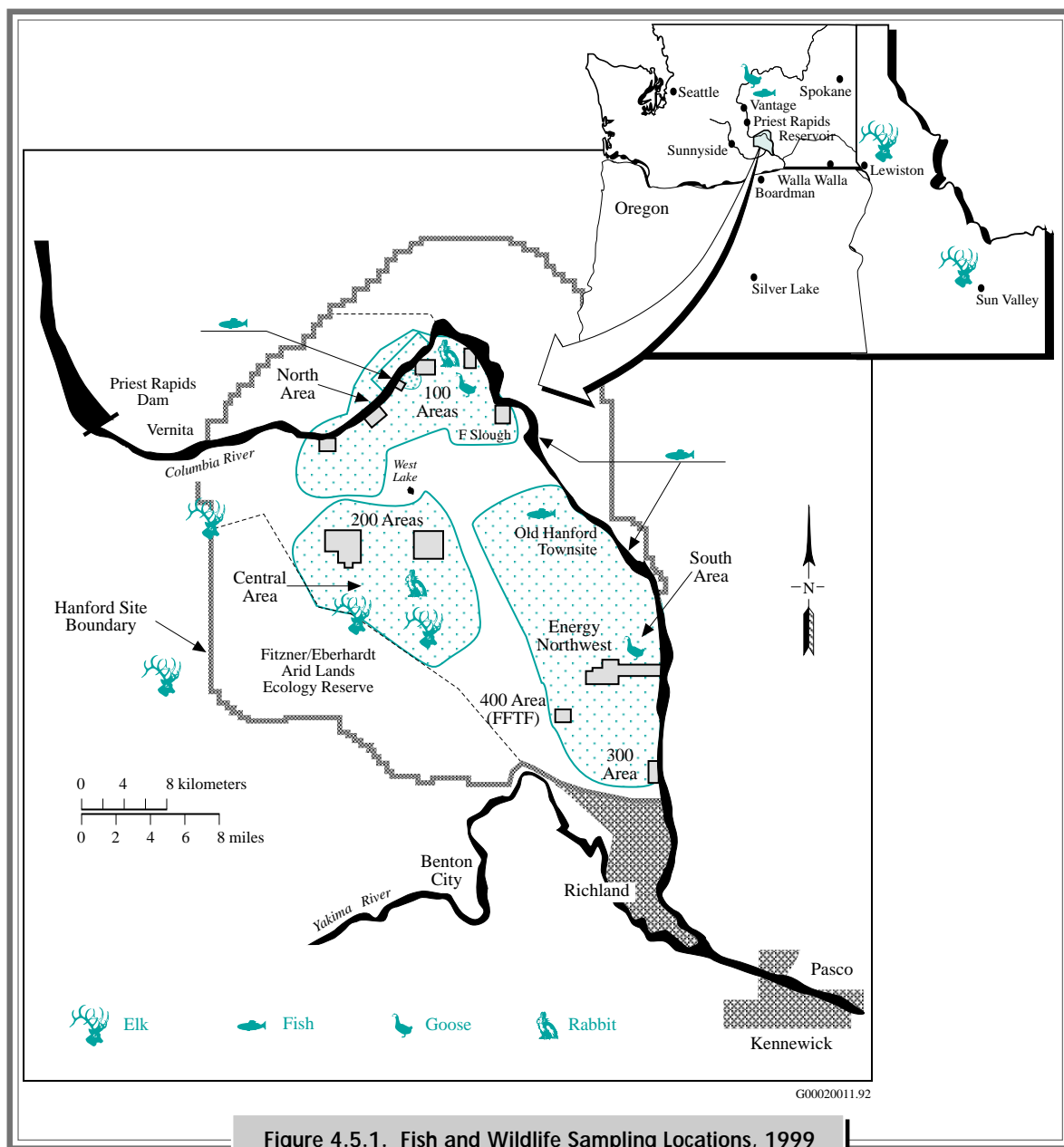
accumulate in wildlife or they did not accumulate in fish or wildlife tissues of interest.

For each species of fish or wildlife, radionuclides are selected for analysis based on the potential for the contaminant to be found at the sampling site and to accumulate in the organism (Table 4.5.1). At the Hanford Site, strontium-90 and cesium-137 have been historically the most frequently measured radionuclides in fish and wildlife.

Strontium-90 is chemically similar to calcium; consequently, it accumulates in hard tissues rich in calcium such as bone, antlers, and eggshells. Strontium-90 has a biological half-life in hard tissue of 14 to 600 days. Hard-tissue concentrations may profile an organism's lifetime exposure to strontium-90. However, strontium-90 generally does not contribute much to human dose because it does not accumulate in edible portions of fish and wildlife. Spring water in the 100-N Area is the primary source of strontium-90 from Hanford to the Columbia River; however, the current contribution relative to historical fallout from atmospheric weapons testing is small (less than 2%) (PNL-8817).

Cesium-137 is particularly important because it is chemically similar to potassium and is found in the muscle tissue of fish and wildlife. Having a relatively short biological half-life (less than 200 days in muscle; less than 20 days in the gastrointestinal tract), cesium-137 is an indicator of more recent exposure to radioactive materials and is also a major constituent of historical fallout.

Fish and wildlife samples were analyzed by gamma spectrometry to detect a number of gamma emitters (see Appendix E). However, gamma spectrometry results for most radionuclides are not discussed here because levels were too low to measure or measured



**Figure 4.5.1. Fish and Wildlife Sampling Locations, 1999**

concentrations were considered artifacts of low-background counts. Low-background counts occur at random intervals during sample counting and can produce occasional spurious false-positive results.

For many radionuclides, concentrations are below levels that can be detected by the analytical laboratory. When this occurs for an entire group of samples, two times the total propagated analytical uncertainty

is used as an estimate of the nominal detection level for that analyte and particular medium. Results and propagated uncertainties for all results may be found in PNNL-13230, APP. 1.

Wet-weight analytical detection levels for cesium-137 in muscle and strontium-90 in bone/carcass tissues were 0.04 pCi/g and 0.01 pCi/g, respectively.



**Table 4.5.1. Locations, Species, and Contaminants Sampled for Fish and Wildlife, 1999**

| <b>Biota</b>                       | <b>No. of Offsite<br/>Locations</b> | <b>No. of Onsite<br/>Locations</b> | <b>No. of Analyses</b> |                     |
|------------------------------------|-------------------------------------|------------------------------------|------------------------|---------------------|
|                                    |                                     |                                    | <b>Gamma</b>           | <b>Strontium-90</b> |
| Fish (suckers,<br>whitefish, bass) | 2 <sup>(a)</sup>                    | 3 <sup>(b)</sup>                   | 10                     | 10                  |
| Canada goose                       | 1 <sup>(c)</sup>                    | 2 <sup>(d)</sup>                   | 11                     | 11                  |
| Elk                                | 2 <sup>(e)</sup>                    | 3 <sup>(f)</sup>                   | 28                     | 25                  |
| Rabbits                            | 0                                   | 3                                  | 8                      | 8                   |

- (a) Background samples collected from the Columbia River in the Priest Rapids and Wanapum reservoirs.  
 (b) Samples collected from 100-N to 100-D and 300 Areas.  
 (c) Sample collected at Vantage, Washington.  
 (d) Samples collected from 100-D to 100-H Area.  
 (e) Samples collected in central Idaho.  
 (f) Samples collected along Highways 240 and 24, adjacent private land, and near BC cribs (see Figure 4.5.1).

## 4.5.1 Fish Samples and Analytes of Interest

In 1999, Pacific Northwest National Laboratory staff collected a total of 16 fish samples (bass, whitefish, and large-scale suckers) from the Columbia River. Six of the 16 samples were collected 64 to 80 kilometers (40 to 50 miles) upstream of the Hanford Site. Fillets and the eviscerated remains (carcass) of fish were analyzed for radiological contaminants. All analytical data for 1999 samples are given in PNNL-13230, APP. 1.

Fillet (muscle) samples were analyzed with gamma spectrometry for cesium-137 and other gamma-emitting radionuclides (PNNL-13230, APP. 1). Cesium-137 was not detected in any of the 10 fish fillet samples collected along the Hanford Reach in 1999 nor in the 6 samples collected upstream the Hanford Site. These results are consistent with previous fish sample results obtained in 1998. Nearly 80% (41 of 55) of fish samples collected between 1990 and 1999 had concentrations of cesium-137 that were below analytical detection limits.

Strontium-90 was found in 7 of 16 fish carcass samples collected and analyzed in 1999 (Table 4.5.2). Mean levels of strontium-90 in carcass tissues collected from the Hanford Reach in 1999 were not significantly different from those observed in Hanford Reach samples collected over the preceding 9 years or from the background area near Vantage, Washington.

Overall, radionuclide concentrations in Hanford Reach fishes were similar to levels observed in background carp and suckers and have generally declined in the past two decades. Figure 4.5.2 demonstrates trends in strontium-90 concentrations in bass carcasses from 1983 to 1999. The associated hypothetical dose from the consumption of Hanford Reach fish is found in Section 5.0, "Potential Radiological Doses from 1999 Hanford Operations."



**Table 4.5.2. Strontium-90 Concentrations (pCi/g) in Columbia River Fish Carcasses, 1999 Compared to Previous 9 Years**

| Location                       | 1999                   |                     |  | 1990-1998                 |                            |  |
|--------------------------------|------------------------|---------------------|--|---------------------------|----------------------------|--|
|                                | Maximum <sup>(a)</sup> | Mean <sup>(b)</sup> | No. Above Detection Limit <sup>(c)</sup> | Maximum <sup>(a)</sup>    | Mean <sup>(b)</sup>        | No. Above Detection Limit <sup>(c)</sup> |
| <b>Strontium-90 in Carcass</b> |                        |                     |  |                           |                            |  |
| 100-N to                       |                        |                     |  |                           |                            |  |
| 100-D Areas                    | 0.02 ± 0.02            | 0.02 ± 0.02         | 0 of 5                                   | 0.06 ± 0.02               | 0.04 ± 0.009               | 8 of 8                                   |
| Hanford Slough                 | 0.05 ± 0.04            | NA <sup>(d)</sup>   | 0 of 1                                   | 0.02 ± 0.007              | NA                         | 1 of 1                                   |
| 100-F Slough                   | 0.06 ± 0.03            | 0.04 ± 0.01         | 4 of 4                                   | 0.04 ± 0.03               | 0.02 ± 0.004               | 20 of 20                                 |
| Background <sup>(e)</sup>      | 0.08 ± 0.02            | 0.04 ± 0.02         | 3 of 6                                   | 0.1 ± 0.02 <sup>(f)</sup> | 0.07 ± 0.01 <sup>(f)</sup> | 25 of 25                                 |

(a) Maximum is ± total propagated uncertainty (2 sigma).

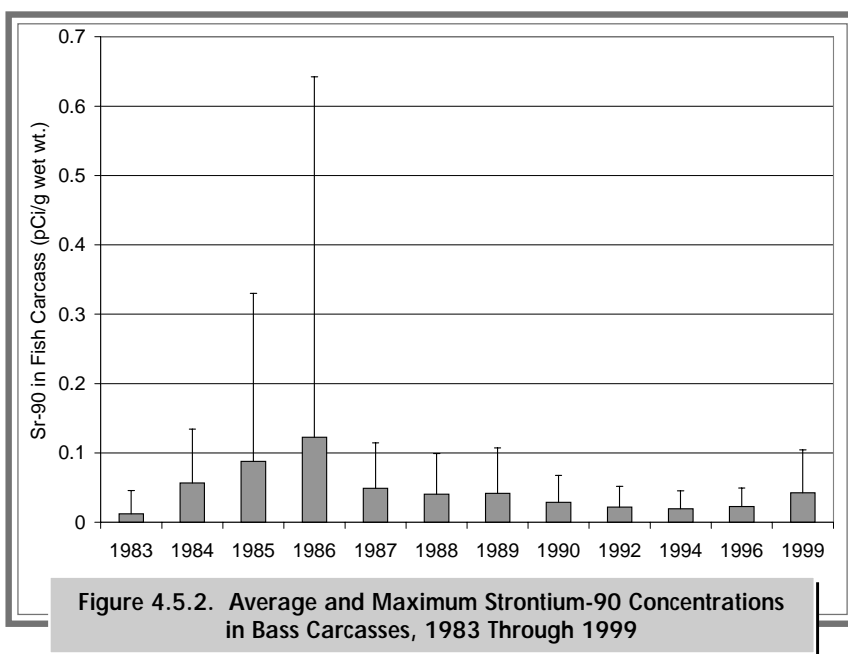
(b) Result is ±2 standard error of the mean.

(c) Number of samples with values above the detection limit out of number of samples analyzed.

(d) NA = Not applicable; only one sample.

(e) Background samples were suckers and bass collected from the Columbia River near Vantage, Washington.

(f) Background samples were carp and suckers collected from the Columbia River near Vantage, Washington in 1992 and 1998.





## 4.5.2 Wildlife Sampling

Wildlife sampled and analyzed for radioactive constituents in 1999 included elk, geese, and rabbits. Radiological constituents analyzed for in 1999 wildlife samples included gamma emitters and strontium-90.

### 4.5.2.1 Elk Samples and Analytes of Interest

Radionuclide levels in elk collected onsite were compared to levels in elk collected at two locations in Idaho. Additionally, onsite levels in elk were compared to levels in deer sampled from 1995 through 1998. These comparisons with samples from distant locations are useful in evaluating the impact of Hanford operations and cleanup activities to large-bodied herbivores. The elk collected in central Idaho inhabited mountain regions that received more rainfall than Hanford.

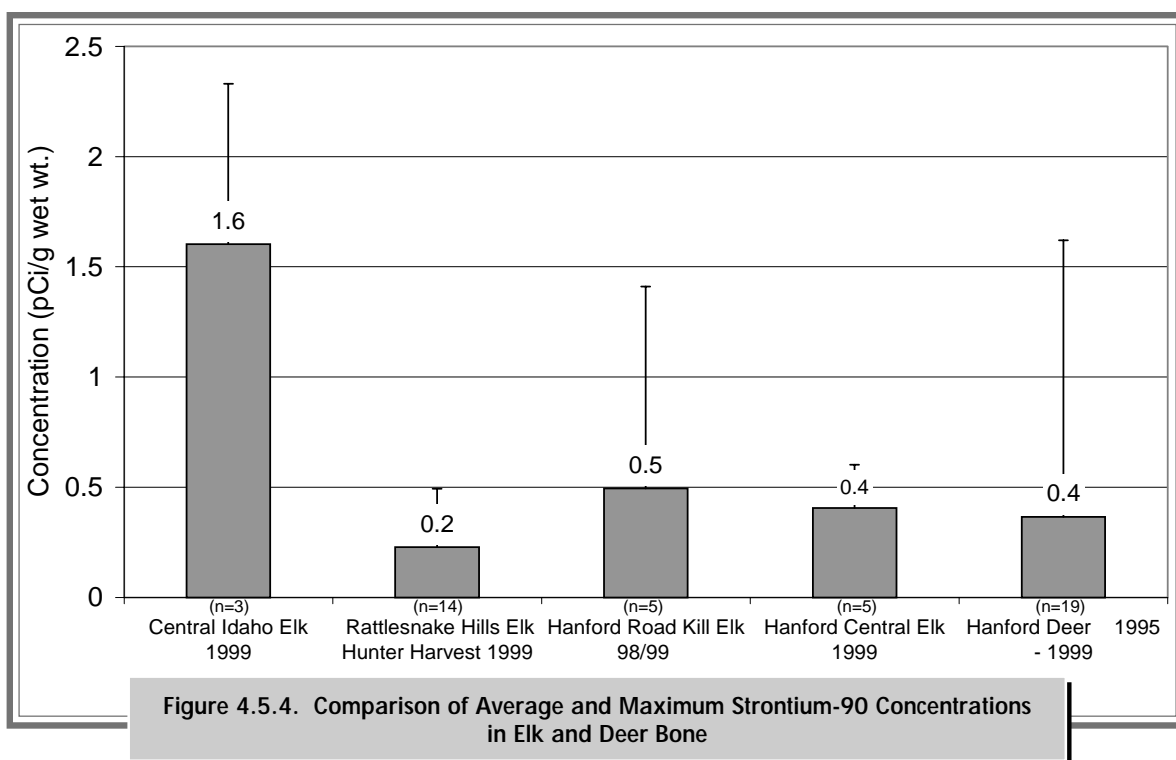
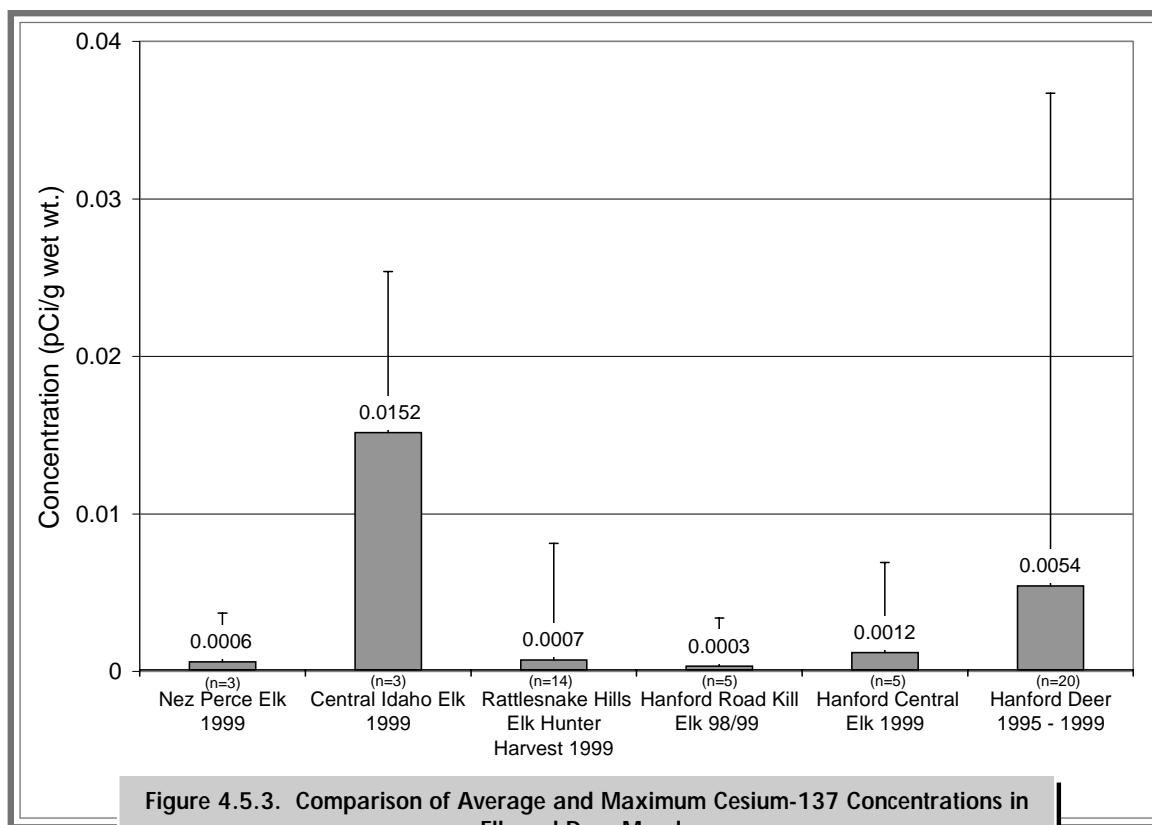
Until recently, elk have not inhabited areas on the Hanford Site where the potential for uptake of radionuclide contaminants exists (see Section 7.2, “Ecosystem Monitoring [Plants and Wildlife]”). There are very few data available about contaminant concentrations in elk residing on or near the Hanford Site. As such, nontraditional tissues (heart, liver, kidney, intestines) were also collected and analyzed for a baseline of gamma-emitting radionuclides, and uranium, plutonium, and strontium radioisotopes.

**Radiological Results for Elk Samples.** Fourteen samples of elk muscle and bone were donated by local sportsman that hunted the Rattlesnake Hills in 1999. Three muscle and bone samples were donated by sportsmen from a 1999 Idaho elk hunt near Sun Valley, Idaho. Three elk muscle samples were donated by the Nez Perce Tribe near Lewiston, Idaho. In addition, samples of muscle, bone, liver, heart, kidney, intestine, and feces were collected from a road-kill elk near the Hanford Site and from five other elk that were collected on the central plateau near the

200 Areas. Cesium-137 was not detected in any of the 24 elk muscle samples collected from on or near the Hanford Site (Figure 4.5.3). Three muscle samples collected from central Idaho were the only ones above analytical detection limits. These results are consistent with historic deer results and with the trends observed in a Hanford wildlife summary report (PNL-10174). Cesium-137 concentrations in muscle samples from the three elk donated by the Nez Perce Tribe were all below analytical detection as were those elk samples collected from on or near the Hanford Site. PNL-10174 summarized wildlife radionuclide data collected from 1983 through 1992 and indicated a decline in cesium-137 levels in all wildlife examined. In addition, the levels of cesium-137 found in over 60 Hanford Site deer muscle samples collected during the 1990s were less than the background levels measured in deer samples collected from 1991 through 1995 from Stevens County, Washington, and in 1996, from Vail, Colorado (PNNL-12088).

The risk associated with radionuclide contamination found in elk or deer muscle during the 1990s can be quantified by the expected dose resulting from consumption of meat. A 50-year effective dose equivalent resulting from the consumption of 41 kilograms (90 pounds) of meat per year collected from a Hanford Site deer, containing the highest cesium-137 levels found in the 1990s, was determined to be 0.041 millirem. An individual would need to ingest ~100,000 kilograms (220,000 pounds) of deer meat to approach the 100-millirem maximum annual dose allowed by DOE Order 5400.5 and the National Council on Radiation Protection and Measurements (1993). To put this dose estimate in perspective, natural background doses in the United States average ~300 millirems per year.

Strontium-90 was detected in bone from all 27 elk samples analyzed in 1999 (see Figure 4.5.4) and compliment the regional cesium-137 differences





found in the elk muscle samples. Again, central Idaho samples were nearly three times higher than any other samples submitted.

#### 4.5.2.2 Goose Samples and Analytes of Interest

Eight goose samples were collected from the Hanford Reach and three were collected from the background location near Vantage, Washington in the early fall of 1999 (see Figure 4.5.1). Radionuclide levels found in these samples were compared to levels in samples collected onsite in 1994, 1995, and 1997.

Cesium-137 was detected in only one of eight goose muscle samples collected from the Hanford Site and one of three from the background site in 1999 (Table 4.5.3). The number of results reported at or below the analytical detection limit in 1999 was similar to those reported for 22 goose samples collected from the Hanford Reach between 1994 and

1997. The 1999 levels were consistent with levels reported for other waterfowl collected on the Hanford Site (PNL-10174).

Strontium-90 concentrations found in goose bone were similar between areas on the Hanford Site in 1999 and the background samples. Using 1 rad per day as a benchmark for biological effects, a concentration of more than 600 pCi/g in bone tissue would be required to cause adverse effects, such as bone tumors.

#### 4.5.2.3 Rabbit Samples and Analytes of Interest

Rabbits are good indicators of regional radioactive contamination because they have relatively small home ranges, occupy burrows, and can enter fenced-restricted areas. However, due to the cyclical patterns of the populations over time, sampling rabbits can be very difficult when numbers are low. In

**Table 4.5.3. Cesium-137 and Strontium-90 Concentrations (pCi/g) in Canada Geese, 1999 Compared to Previous 5 Years**

| Location                    | 1999                   |                     |  | 1994-1997              |                     |  |
|-----------------------------|------------------------|---------------------|--|------------------------|---------------------|--|
|                             | Maximum <sup>(a)</sup> | Mean <sup>(b)</sup> | No. Above Detection Limit <sup>(c)</sup> | Maximum <sup>(a)</sup> | Mean <sup>(b)</sup> | No. Above Detection Limit <sup>(c)</sup> |
| <b>Cesium-137 in Muscle</b> |                        |                     |  |                        |                     |  |
| 100-N to 100-D Area         | 0.009 ± 0.007          | 0.003 ± 0.004       | 0 of 5                                   | 0.04 ± 0.02            | 0.01 ± 0.01         | 1 of 11                                  |
| Old Hanford Townsite        | 0.05 ± 0.02            | 0.024 ± 0.03        | 1 of 3                                   | 0.03 ± 0.01            | 0.006 ± 0.005       | 1 of 11                                  |
| Background <sup>(d)</sup>   | 0.07 ± 0.02            | 0.03 ± 0.04         | 1 of 3                                   | NS <sup>(e)</sup>      | NS                  | NS                                       |
| <b>Strontium-90 in Bone</b> |                        |                     |  |                        |                     |  |
| 100-N to 100-D Area         | 0.2 ± 0.07             | 0.1 ± 0.09          | 3 of 5                                   | 0.7 ± 0.1              | 0.2 ± 0.1           | 11 of 11                                 |
| Old Hanford Townsite        | 0.4 ± 0.04             | 0.07 ± 0.04         | 3 of 3                                   | 0.4 ± 0.1              | 0.1 ± 0.08          | 11 of 11                                 |
| Background <sup>(d)</sup>   | 0.4 ± 0.05             | 0.8 ± 0.2           | 2 of 3                                   | NS                     | NS                  | NS                                       |

(a) Maximum is ± total propagated analytical uncertainty (2 sigma).

(b) Result is ±2 standard error of the mean.

(c) Number of samples with values above the detection limit out of number of samples analyzed.

(d) Background samples collected from Yakima Valley near Sunnyside, Washington.

(e) NS = No sample.



1999, the black-tailed jackrabbit was identified by Washington State Department of Fish and Wildlife as a species of concern. On the Hanford Site, the number of black-tailed jackrabbits has remained relatively stable throughout the 1990s and is likely related to the habitat provided by an overstory of sagebrush there.

In 1999, muscle and bone samples of jackrabbits and cottontails were collected from near the 200-East, 200-West, and 100-N Areas. Background samples of rabbits were collected in 1990.

**Muscle.** Cesium-137 concentrations in eight rabbits collected on the Hanford Site in 1999 were all below analytical detection limit except one, which was just slightly above the detection limit (Table 4.5.4). These results are similar to those seen from background locations sampled in 1990 and do not indicate elevated exposures from Hanford-derived sources.

**Bone.** Strontium-90 concentrations in bone tissue of eight rabbits on the site were all above the analytical detection limit. Results from animals collected near the 200 Areas do not suggest a significant exposure attributable to Hanford Site operations. Only one cottontail rabbit was collected from 100-N Area in 1999, limiting the ability to statistically compare the results ( $144 \pm 32$  pCi/g wet wt.), however, this single value was over 20 times higher than concentrations from all other samples submitted in 1999 and suggests onsite exposure to low levels of strontium-90 around the 100-N Area. Future small mammal sampling efforts at the same sampling locations may shed some insight to strontium-90 sources in or near the 100-N Area that are available for biological uptake.

**Table 4.5.4. Cesium-137 and Strontium-90 Concentrations (pCi/g) in Rabbits, 1999 Compared to Previous 9 Years**

| <b>Location</b>             | <b>1999</b>                  |                           |  | <b>1990-1998</b>             |                           |  |
|-----------------------------|------------------------------|---------------------------|--|------------------------------|---------------------------|--|
|                             | <b>Maximum<sup>(a)</sup></b> | <b>Mean<sup>(b)</sup></b> | <b>No. Above Detection Limit<sup>(c)</sup></b> | <b>Maximum<sup>(a)</sup></b> | <b>Mean<sup>(b)</sup></b> | <b>No. Above Detection Limit<sup>(c)</sup></b> |
| <b>Cesium-137 in Muscle</b> |                              |                           |  |                              |                           |  |
| 200 Areas                   | $0.05 \pm 0.02$              | $0.01 \pm 0.04$           | 1 of 7   | $0.25 \pm 0.05$              | $0.02 \pm 0.02$           | 11 of 22                                       |
| 100-N Area                  | $0.03 \pm 0.04$              | -                         | 0 of 1   | $0.14 \pm 0.1$               | $0.005 \pm 0.03$          | 1 of 10  |
| Background <sup>(d)</sup>   | NS <sup>(e)</sup>            | NS                        | NS   | $0.03 \pm 0.03$              | $0.005 \pm 0.005$         | 1 of 20  |
| <b>Strontium-90 in Bone</b> |                              |                           |  |                              |                           |  |
| 200 Areas                   | $4.8 \pm 1.1$                | $1.6 \pm 2.0$             | 7 of 7   | $48.5 \pm 9.0$               | $8.5 \pm 10.1$            | 22 of 22                                       |
| 100-N Area                  | $144.0 \pm 32.0$             | -                         | 1 of 1   | $81.3 \pm 14.0$              | $14.6 \pm 16.0$           | 10 of 10                                       |
| Background <sup>(d)</sup>   | NS <sup>(e)</sup>            | NS                        | NS   | $0.9 \pm 0.09$               | $0.35 \pm 0.09$           | 20 of 20                                       |

(a) Maximum is  $\pm 2$  total propagated analytical uncertainty (2 sigma).

(b) Mean is  $\pm 2$  standard error of the mean.

(c) Number of samples with values above the analytical detection limit out of number of samples analyzed.

(d) Background samples collected near Boardman, Oregon, in 1990.

(e) NS = No sample.